Network Working Group
Request for Comments: 799

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September 1981

Internet Name Domains

1. Introduction

In the long run, it will not be practicable for every internet host to include all internet hosts in its name-address tables. Even now, with over four hundred names and nicknames in the combined ARPANET-DCNET tables, this has become awkward. Some sort of hierarchical name-space partitioning can easily be devised to deal with this problem; however, it has been wickedly difficult to find one compatible with the known mail systems throughout the community. The one proposed here is the product of several discussions and meetings and is believed both compatible with existing systems and extensible for future systems involving thousands of hosts.

2. General Topology

We first observe that every internet host is uniquely identified by one or more 32-bit internet addresses and that the entire system is fully connected. For the moment, the issue of protocol compatibility will be ignored, so that all hosts can be assumed MTP-competent. We next impose a topological covering on the space of all internet addresses with a set of so-called name domains. In the natural model, name domains would correspond to institutions such as ARPA, UCL and COMSAT, and would not be necessarily disjoint or complete. While in principle name domains could be hierarchically structured, we will assume in the following only a single-level structure.

Every name domain is associated with one or more internet processes called mail forwarders and the name of that domain is the name for any of these processes. Each forwarder process for a particular domain is expected to maintain duplicate name-address tables containing the names of all hosts in its domain and, in addition, the name of at least one forwarder process for every other domain. Forwarder processes may be replicated in the interests of robustness; however, the resulting complexities in addressing and routing will not be discussed further here. A particular internet host may support a number of forwarder processes and their collective names represent nicknames for that host, in addition to any other names that host may have. In the following an internet host supporting one or more forwarder proceses will be called simply a forwarder.

Every host is expected to maintain name-address tables including the names of at least one forwarder for every

domain together with additional hosts as convenient. A host may belong to several domains, but it is not necessary that all hosts in any domain, be included in its tables. Following current practice, several nicknames may be associated with the principal name of a host in any domain and these names need not be unique relative to any other domain. Furthermore, hosts can be multi-homed, that is, respond to more than one address. For the purpose of mail forwarding and delivery, we will assume that any of these addresses can be used without prejudice. The use of multi-homing to facilitate source routing is a topic for future study.

3. Naming Conventions

In its most general form, a standard internet mailbox name has the syntax

<user>.<host>@<domain> ,

where <user> is the name of a user known at the host <host> in the name domain <domain>. This syntax is intended to suggest a three-level hierarchically structured name (reading from the right) which is unique throughout the internet system. However, hosts within a single domain may agree to adopt another structure, as long as it does not conflict with the above syntax and as long as the forwarders for that domain are prepared to make the requisite transformations. For instance, let the name of a domain including DCNET be COMSAT and the name of one of its hosts be COMSAT-DLM with Mills a user known to that host. From within the COMSAT domain the name Mills@COMSAT-DLM uniquely identifies that mailbox as could, for example, the name Mills.COMSAT-DLM@COMSAT from anywhere in the internet system. However, Mills@COMSAT-DLM is not necessarily meaningful anywhere outside the COMSAT domain (but it could be).

A typical set of name domains covering the current internet system might include ARPA (ARPANET), COMSAT (DCNET), DCA (EDNET, WBNET), UCL (UCLNET, RSRENET, SRCNET), MIT (CHAOSNET), INTELPOST (INTELPOSTNET) and the various public data networks. The ARPA forwarder would use a name-address table constructed from the latest version of the HOSTS.TXT table in the NIC data base. The other forwarders would construct their own, but be expected to deposit a copy in the NIC data base.

4. Mail Transport Principles

In the interests of economy and simplicity, it is expected that the bulk of all mail transport in the internet system will take place directly from originator to recipient

host and without intermediate relay. A technique of caching will probably be necessary for many hosts in order to reduce the traffic with forwarders merely to learn the internet address associated with a correspondent host. This naturally encourages naming strategies designed to minimize duplicate names in the various domains; however, such duplicates are not forbidden.

There are several reasons why some messages will have to be staged at an intermediate relay, among them the following:

1. It may not be possible or convenient for the originator and recipient hosts to be up on the internet system at the same time for the duration of the transfer.

2. The originator host may not have the resources to perform all name-address translations required.

3. A direct-connection path may not be feasible due to regulatory economic or security constraints.

4. The originator and recipient hosts may not recognize the same lower-level transport protocol (e.g. TCP and NCP).

A mail relay is an internet process equipped to store an MTP message for subsequent transmission. A mail forwarder is a mail relay, but not all relays are forwarders, since they might not include the full name-address capability required of forwarders. In addition, relays may not be competent in all domains. For instance, a MTP/TCP relay may not understand NCP. In other words, the forwarders must be fully connected, but the relays may not.

The particular sequence of relays traversed by a message is determined by the sender by means of the source route specification in the MRCP command. There are several implications to this:

1. Advisory messages returned to the originator by a relay or recipient host are expected to traverse the route in reverse order.

2. Relay host names follow the same naming convention as all host names relative to their domain. Since it may not be possible (see below) to use internet addresses to dis-ambiguate the domain, the complete standard internet name .<host>@<domain> is required everywhere.

3. There is no current provision for strict/loose route specifications. If, in fact, the "ordinary" host specification @<host> were used, each relay or forwarder

would use the rules outlined in the next section for routing. This may result in additional relay hops.

5. Forwarder Operations

This section describes a likely scenario involving hosts, relays and forwarders and typical internet routes. When a forwarder receives a message for <user>.<host>@<domain>, it transforms <host> if necessary and forwards the message to its address found in the name-address table for <domain>. Note that a single host can be a forwarder for several independent domains in this model and that these domains can intersect. Thus, the names Mills@USC-ISIE, Mills.USC-ISIE@ARPA and Mills.USC-ISIE@COMSAT can all refer to the same mailbox and the names USC-ISIE, ARPA and COMSAT can, conceivably, all be known in the same domain. Such use would be permissable only in case the name USC-ISIE did not conflict with other names in this domain.

In order for this scheme to work efficiently, it is desireable that messages transiting forwarders always contain standard internet mailbox names. When this is not feasible, as in the current ARPANET mail system, the forwarder must be able to determine which domain the message came from and edit the names accordingly. This would be necessary in order to compose a reply to the message in any case.

In the RFC-780 model a message arriving at a forwarder is processed by the MTP server there. The server extracts the first entry in the recipient-route field of an MRCP command. There are two cases, depending on whether this entry specifies a domain name or a host name. If a domain name, as determined by a search of a universal table, it refers to one of the domains the server represents. If not, it must a name or nickname of the server's host relative to ooe of the domains to which the sender belongs. This allows a distinction to be made between the domains COMSAT and INTELPOST on one hand and the COMSAT host COMSAT-PLA on the other, all of which might be represented by the same internet address, and implies that domain names must be unique in all domains.

The server next extracts the second entry in the recipient-route field of the MRCP command and resolves its address relative to the domain established by the first entry. If the second entry specifies an explicit domain, then that overrides the first entry. If not and the first entry specifies a domain, then that domain is effective. However, if the first entry specifies the server's host, it may not be apparent which domain is intended. For instance, consider the following two MRCP commands:

MRCP to:<@COMSAT,Mills@HOST> and
MRCP to:<@INTELPOST,Mills@HOST> ,

where Mills.HOST@COMSAT and Mills.HOST@INTELPOST are distinct mailboxes on different hosts. A receiving host supporting forwarders for both COMSAT and INTELPOST can then preserve this distinction and forward correctly using the above rules.

Now let the forwarder host have the name FORWARDER in both the COMSAT and INTELPOST domains and consider its options when receiving the command

MRCP to:<@FORWARDER,Mills@HOST> .

The forwarder is being asked simply to relay within the domain of the sender; however, it belongs to more than one domain! The obvious way to resolve this issue would be to forbid the use of implicit domains, as represented by Mills@HOST, and require the full internet mailbox names Mills.HOST@COMSAT or Mills.HOST@INTELPOST. It is also possible to dis-ambiguate the domain by inspecting the first entry of the sender-route field of the MAIL command (see below).

6. Source and Return Routing

In the RFC-780 model, routes can be specified in the recipient-route field of the MRCP command and in the sender-route field of the MAIL command. In point of fact, neither the recipient-route or sender-route is necessary if the originator specifies standard internet mailbox names. So long as the routes, when used, consist only of domain names, there is no conflict with the current RFC-780 specification. If for some reason forwarding must be done via other hosts, then the use of a complete and unambigous syntax like .<host>@<domain> is required in order to avoid problems like that described above.

The present RFC-780 specification requires the receiver to construct a name for the sender and insert this at the beginning of the sender-route. Presumably, the only information it has to construct this name is the internet address of the sender. Consider the case, as in the example above, where multiple domains are supported by a single server on a particular host. If hosts receiving a message relayed via that server were to map its address into a name, there would be no way to determine which domain was intended. We conclude that the sending host must update the sender-route as well as the recipient-route. It does this simply by copying the first entry in the recipient-route as received as the new first entry in the sender-route.

7. Editing the RFC-733 Header

Every effort should be made to avoid editing the RFC-733 header, since this is an invasive procedure requiring extensive analysis. It is expected that newly developed mail systems will be aware of the standard internet mailbox syntax and ensure its use everywhere in the RFC-733 and RFC-780 fields. On the occasions where this is not possible, such as in many current ARPANET hosts, the necessary editing should be performed upon first entry to the internet mail system from the local mail system. This avoids the problems mentioned above and simplifies reply functions.

In the case of ARPANET hosts, the editing operations assume that all names in the form <anything>@<domain>, where <domain> is the name of a domain, are unchanged. Names in the form <anything>@<host>, where <host> is the name of a host in the ARPA domain, are transformed to the form <anything>.<host>@ARPA. Anything else is an error. Before handing off to an ARPANET NCP mailer, an ARPA MTP forwarder might optionally transform <anything>.<host>@ARPA to <anything>@<host> in order to reduce the forwarder traffic when local mail systems are available. Similar situations might exist elsewhere.

8. Concluding Remarks

This memorandum is intended to stimulate discussion, not simulate it.